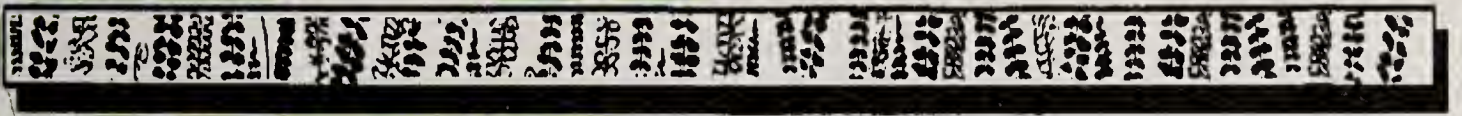




Hardy Fern Foundation Quarterly



Summer 2005

THE HARDY FERN FOUNDATION

P.O. Box 166

Medina, WA 98039-0166

Web site: www.hardyferns.org

The Hardy Fern Foundation was founded in 1989 to establish a comprehensive collection of the world's hardy ferns for display, testing, evaluation, public education and introduction to the gardening and horticultural community. Many rare and unusual species, hybrids and varieties are being propagated from spores and tested in selected environments for their different degrees of hardiness and ornamental garden value.

The primary fern display and test garden is located at, and in conjunction with, The Rhododendron Species Botanical Garden at the Weyerhaeuser Corporate Headquarters, in Federal Way, Washington.

Satellite fern gardens are at the Stephen Austin Arboretum, Nacogdoches, Texas, Birmingham Botanical Gardens, Birmingham, Alabama, California State University at Sacramento, Sacramento, California, Coastal Maine Botanical Garden, Boothbay, Maine, Dallas Arboretum, Dallas, Texas, Denver Botanic Gardens, Denver, Colorado, Georgeson Botanical Garden, University of Alaska, Fairbanks, Alaska, Harry P. Leu Garden, Orlando, Florida, Inniswood Metro Gardens, Columbus, Ohio, Lewis Ginter Botanical Garden, Richmond, Virginia, New York Botanical Garden, Bronx, New York, and Strybing Arboretum, San Francisco, California.

The fern display gardens are at Bainbridge Island Library, Bainbridge Island, WA, Lakewold, Tacoma, Washington, Les Jardins de Metis, Quebec, Canada, University of Northern Colorado, Greeley, Colorado, and Whitehall Historic Home and Garden, Louisville, KY.

Hardy Fern Foundation members participate in a spore exchange, receive a quarterly newsletter and have first access to ferns as they are ready for distribution.

Cover Design by Willanna Bradner

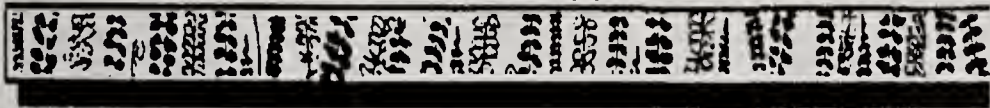
HARDY FERN FOUNDATION QUARTERLY

THE HARDY FERN FOUNDATION

QUARTERLY

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The Spore Exchange Needs You!

Please send your spores to our Spore Exchange Director:

Katie Burki
501 S. 54th St.
Tacoma, WA 98408

President's Message

Summer 2005

The apprehension that the Pacific Northwest region may suffer a drought this summer, because of the past winter's dry weather, has been abated due to the nice intermittent rains that have been with us through spring and into the summer. As we get into the second week of July, cloudy skies are sweeping into the region giving an occasional light drizzle. The ferns and hydrangeas have never looked so good. Heavy new growth cloaks our native tress and shrubs.

The Fern Festival, held this past first weekend of June, was a very good success. With the local weather forecasters predicting a dry year and all the garden talk of growing drought tolerant plants, we feared that the sale of ferns would drop off significantly from the record sales of the previous year. To our surprise nearly as many ferns were sold. Though we did not experience the rampant rush of fern buyers from 2004, the sales were steady throughout the two day sale. This year we also had a greater selection and number of ferns available. Friday evening, Richie Steffen gave a very informative and eye opening talk on his plant hunting travels in Chile this past winter, accompanied with beautiful slides of plants and landscapes. Thank You, Richie. We were fortunate to have Dr. David Mabberley, the newly appointed director of the Center of Urban Horticulture, the Washington Park Arboretum and the Elisabeth Miller Botanical Library join us for this evening. He addressed the audience during the annual meeting conveying his goals in bringing these three entities within the University of Washington into a more cooperative and cohesive venture. He expressed the importance that various plant organizations give and congratulated the Hardy Fern Foundation on their efforts and accomplishments.

Highlights of HFF accomplishments during the past year;

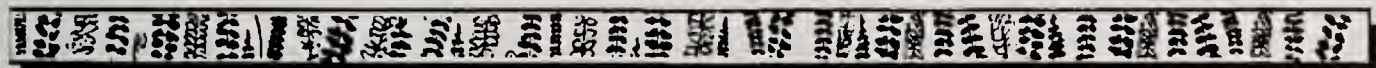
1. The continuation of the Fern Habitat Display Garden at the Washington Park Arboretum. Thank You Lyman Black for your efforts in keeping this display in excellent order.
2. Our continuing presence at Northwest Garden Show.
3. The special edition of the spring HFF Quarterly that focused on fern evaluations from HFF members throughout the continent. A special Thank You to Sue Olsen for leading this very time consuming and involved work.
4. The inclusion of HFF reference materials into the Elisabeth Miller Botanical Library. Thank You Sylvia Duryee and Jocelyn Horder for your generosity and time in seeing this work to its conclusion.

5. The continuing work in expanding the HFF web site into a more inter-active and informative vehicle.
6. And the continuing efforts in procuring more new fern species for propagation and evaluations.

New fronds of *Dryopteris lepidopoda* and *Dryopteris erythrosora* are still showing their glowing colors of burnt orange to orange-yellow. New *Blechnum chilense* fronds continue to emerge and unfurl. I am still getting newly unfurling fronds of *Woodwardia unigemmata*, blood red in color. *Dryopteris wallichiana* stands boldly with dark green pinnae set off by their black rachis and bristly black stipes.

Best regards.

John van den Meerendonk



Dryopteris caucasica

James Horrocks - Salt Lake City, Utah

This species was named after the Caucasus, a region between the Black Sea and the Caspian, including the Caucasus Mountains. It is a sexual diploid from southeastern Europe and southwest Asia, inhabiting the mountainous areas of the Middle East from southern Russia into Turkey and beyond but is not found in the Indian subcontinent or the Himalayas. It is one of the parent species of *Dryopteris filix-mas*, a sexual allotetraploid species (or more properly, a segmental allopolyploid) the other parent being *D. oreades*. *D. caucasica* could be confused with any number of *Dryopteris* species. It is often confused with *D. filix-mas* but is lighter green and has pinnules with double-toothed margins. The indusia remain white until shriveling and the spores are very dark brown, which especially distinguishes it from *D. filix-mas*. *D. caucasica* has proven to be very cold-hardy, withstanding temperatures well below zero in the author's garden in northern Utah.



Dryopteris caucasica.
Photo by Richard Young,
Salt Lake City.

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Germany Fern Excursion June-July 2006

Second Circular – July 2005

Dr. Berndt Peters is planning a fern tour to Middle, North and Eastern Germany, for probably June 30th – July 09th 2006. The number of participants will be limited to 25 due to the small size of a few of the private gardens. Minimum number will be 12 participants.

Excursion program: The participants will see a wide range of gardens, all characterized by their ferns, but of very different size and style. Some of them also include interesting collections of other plants. In detail we will see the gardens and collections of the enthusiasts Ingo Carstensen, Siegfried Förster, Wolfram Gaßner, Christian Gutschow, Christian Kohout, Dietrich Nittritz, Dr. Berndt Peters, Hemuth Schmick, Günter Stobbe and Rolf Thiemann.

We will visit also the famous arboretum Ellerhoop near Hamburg and the Arctic-Alpine garden in Chemnitz, see the fern nursery Wiederstein near Koblenz and study ferns in their natural habitats in the Elbsandsteingebirge and near Zöblitz.

In the afternoons and evenings we will have the opportunity to have a look at the old German towns Bremen, Dresden, Koblenz, Lübeck and Schleswig.

(Of course a few changes may become necessary.)

For the participants (for example for couples, where the partner is not interested in ferns), who would like to see something else other than ferns and gardens, there is the possibility to have a day for touristic use or shopping at the 4. and 6. day resp.

Housing: All accommodation will be in good middle-class hotels. Rooms will be double unless you indicate otherwise. Since most of the participants will probably be coming from the UK or the USA, hotel reservations will be made for the day before the tour starts and the day after the farewell dinner.

For those, who arrive in Hamburg rather early at July 29th and who want to see some plants and ferns, we recommend to visit the Botanical garden in Hamburg (on their own).

Meals: Breakfast (either continental-style or a buffet) will be included in the payment. Mostly we will be provided lunch boxes from the hotels, which are also included in the price. Only at July 05th we will have lunch in an inn. This meal and the evening meals are at your own expense. Dinners in the evening will be available in the hotel or within walking distance. The evening meals are not organized (exception: farewell dinner), because of probably different preference for different cuisines.

Tour Details: We will be travelling by charter bus.

We will have the opportunity to show fern slides in the evening of July 04th after the meal in the hotel. If some of the participants are interested to bring slides with them and to show them to the group, please let us know.

Clothing: Climate in Germany is similar as the British climate. In June / July it can be rather hot but there can also be rainy periods. Therefore a range of suitable clothing would be useful.

What is included in the payment:

- bus and driver
- staying overnight in hotels from June 29th to July 10th in double or single rooms resp.
- breakfast
- lunch boxes for 30.06. till 04.07. and 06.07. till 09.07.
- tour of the towns Bremen, Dresden, Lübeck, Koblenz and Schleswig
- entrance of the arboretum Ellerhoop
- farewell dinner at July 09 in Köln
- guided tour or the nature excursions (Elbsandsteingebirge and Zöblitz)
- Mrs. Mandt, a former member of the BPS and born in Ireland, will take part in the tour and will help with translation

The price of the tour depends on the number of participants and on the decision to use double or single rooms in the hotel. For the minimum number of 12 participants the price is 1.670 Euro for double rooms and 1.950 Euro for single rooms resp.

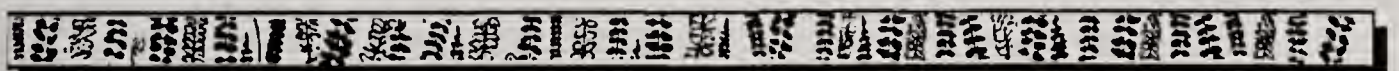
If the number of participants is larger than 12 the price of the tour is decreasing. We have included in this calculation a buffer, so that we hope to get a surplus, which we can remit back to the participants, if there are no unexpected costs.

If you want to take part in this excursion to Germany, please send a message with your address via email or letter to Dr. Berndt Peters, Schleswiger Str. 83, D-24392 Suederbrarup, Germany or berndtpeters@foni.net. Please tell us, whether you want to use double or single rooms resp.

We ask for remittance of 400 Euro before August 31st of 2005 (We will send you the details of the bank account in advance). The rest of the money must be remitted till February 28th of 2006.

In case of cancellation before December 31th of 2005 we will remit the money back to you. In case of cancellation after this date we will detain the costs, which we have with hotels etc.

Important: Each participant has to effect an insurance against damage during the excursion and send a proof of this insurance to the BPS (address: c/o Pat Acock, 13 Star Lane, St. Mary Cray, Kent BR5 3LJ, England), who is the organizer of the travel in judicialal sense.



À La Recherche de Fougères à Paris

By Catharine W. Guiles - New Gloucester, ME

Why, when the Louvre, the Musée d'Orsay, the Eiffel Tower, Notre Dame, La Sainte Chapelle, and hundreds of other monuments to kings, art, God, government, and shopping await one in Paris, why go looking for ferns? Well, why not. After all, they are there! And like so many things in Paris, they come with history.

In October 2004, I had the happy opportunity of spending a week with a relative in the French capitol, and one of the places I particularly wanted to visit was Le Jardin des Plantes.

Like England's Kew Gardens, its origin has ties to the monarchy. It was founded in 1635 by Louis XIII's physician, Guy de la Brosse, and was named the Jardin Royal des Plantes Médicinales. Those who remember reading Alexandre Dumas' *The Three Musketeers* can easily call up a mental picture of those dramatic times. Though the garden is now at the edge of the Latin Quarter, when it was founded, it was out in the country, purposefully away from the unhealthful water and air of the city. In 1640, three years before the death of Louis XIII, it was opened to the public.

One source notes that it was enlarged by a later director, Guy-Crescent Fagon (1638-1718), who was a physician to Louis XIV. An anonymous author adds that this man of medicine succeeded in sending many of the members of the royal family to their graves.

Prior to the French Revolution, well known scientists of the period lived and worked there, foremost among them Georges Louis Leclerc, comte de Buffon (1707-1788), who was the garden's director for fifty years and who doubled its size. It was the scientific home of the three de Jussieu brothers, all botanists, Antoine (1687-1758), Bernard (1699-1777?), and Joseph (1704-1779). The first was a director of the garden, and the third brought back many plants to Europe from travels in South America. Most prominent in the next generation was Jean-Baptiste de Monet, Chevalier de Lamarck (1744-1829), botanist and early proponent of an evolutionary theory. Another was the zoologist and paleontologist Baron Georges Cuvier (1769-1832).

As with all botanical gardens, its collections were enriched by travelers such as Joseph de Jussieu. Among these is a black locust (*Robinia pseudacacia*) transplanted to the garden around 1635. This tree is from North America.

The French Revolution, associated in our minds with widespread destruction of royal, aristocratic, and ecclesiastical institutions was, ironically, a time of growth for garden. First, a zoo was established in 1792 by Bernardin de Saint Pierre (1737-1814), a disciple of Rousseau, novelist, and scientist. The animals came from the private menageries of aristocrats along with tamed monkeys and bears used by Parisian street entertainers! Secondly, the National Convention founded twelve research laboratories and renamed the whole the Muséum Nationale d'Histoire Nationale. In the nineteenth century, well-known French scientists in all fields worked there, among them Henri Becquerel, who, with Pierre and Marie Curie, received the Nobel Prize for Physics for the discovery of radioactivity.

Today, the garden is laid out in the fashion of formal French landscapes. The main gate faces the Seine, and on the other three sides it is bordered by the zoo and by a series of buildings devoted to exhibits of comparative anatomy and paleontology, the cryptogams and seed-bearing plants, paleobotany, entomology, mineralogy, and geology. In addition, one finds conservatories (closed for renovation), a library, a herbarium housing about 7,000,000 specimens and, crowning the whole, the Grande Galérie de l'Évolution.

To move toward the focus of this article, there is yet another institution associated with the Muséum, the École de Botanique. As its descriptive literature makes clear, the Jardin des Plantes has always been an informal school of botany, chemistry and medicine where, to the disgust of the faculty members at the nearby Sorbonne, the teaching was conducted in French, not Latin! Whatever the practices and opinions of the university's professors, the informal teaching continued until 1954, when the École de Botanique was formally organized and charged with "enlightening students, professional horticulturists and amateurs on the requirements of woody and herbaceous plants likely to grow in the Parisian climate." The gardens devoted to this school are organized systematically, either by family or by ecosystem. I recall one bed full of salvias of every color and growth habit. A grove of trees (shade!) alerted me to the fact that, within the school's garden plots, I might find some ferns. And indeed there they were—a line of plants that told me what species the residents of the Île de France might be advised to grow in their gardens. Specifically, these were:

Phyllitis scolopendrium (Hart's tongue fern).

(Listed as *Asplenium scolopendrium*)

Asplenium trichomanes (Maidenhair spleenwort)

Cystopteris fragilis (Fragile fern)

Polypodium vulgare (Common polypody)

Pyrrosia lingua (Tongue, or Felt, fern)

Cyrtomium falcatum (Japanese holly fern)

Gymnocarpium robertianum (Limestone oak fern)

Dryopteris filix-mas (Male fern)

Pteridium aquilinum var. *aquilinum* (Bracken)

Blechnum spicant (Deer fern, Hard fern)

Osmunda regalis var. *regalis* (Royal fern)

Athyrium filix-femina (Lady fern)

Selaginella selaginoides (Lesser—or Low—clubmoss)

Equisetum telmateia (Giant horsetail)

Equisetum x ferrissii Clute (Ferriss's scouring rush)

and finally,

"*Cycas*"

continued on page 24



Phyllitis scolopendrium.
Photo by Catharine
Guiles.

For *Equisitum telmateia* and the cycad, there were no plants, only labels. I wondered darkly if plant thieves had been at work.

From this list, we can determine that Paris has a Zone 6 or 7 climate, and that the botany school places its emphasis on native ferns; *Pyrrosia lingua* and *Cyrtomium falcatum* are the only exotics in the school's garden, both Asian imports.

The *Equisitum x ferrissii* is a puzzle; why does the garden include a hybrid of a circumboreal (*E. hyemale*) and a North American (*E. laevigatum*) plant? Does it have special qualities? Or is it mislabeled?

Right over a fence next to the botany school's gardens, I could see more ferns, but, alas, these were in the alpine garden, which was closed for the season. Had I been able to visit it, I think it likely that the foregoing list might be longer.

*

During our week in Paris, we kept passing the Hôtel de Cluny, which was right down the street from our hotel. This building, dating from 1485, served as the headquarters in Paris for the monks of the important Benedictine Abbaye de Cluny, located in Burgundy. It now houses the Musée Nationale du Moyen Age. It is also surrounded by a garden inspired by the gardens and landscapes of the Middle Ages and, you guessed it, there were some ferns growing in the shade, specifically *Dryopteris filix-mas*, *Athyrium filix-femina*, and *Phyllitis scolopendrium*. As *D. filix-mas* was used as a vermifuge in pre-modern medicine, I was not surprised to find it there. Now these were, admittedly, a humble find, but gratifying nonetheless as I came across them on the last day of our visit.

Sources Consulted

Strollers guide of the "Jardin des Plantes." 1991. Paris: Muséum National d'Histoire Naturelle.

World Wide Web sites for:

Muséum National d'Histoire Naturelle (<http://www.mnhn.fr>).

Visite touristique du 5ème arrondissement (Paris 5eme.com).

Musée Nationale du Moyen Age (<http://www.musee-moyenage.fr>).

Horrocks *continued from page 19*

Description: The rhizome is mostly erect or ascending, but horizontal below the surface and quite stout, occasionally forming offshoots, more often in cultivation than in the wild. The fronds can reach 2 to 2 ½ feet, or more rarely 3 feet long and 10 to 12 inches wide, held erect but spreading. The stipe is between ¼ and ½ the length of the blade and the scales are rather sparse, light brown, narrowly triangular to ovate-lanceolate. The frond outline is for the most part ovate-lanceolate to elliptic. The herbaceous twice-pinnate fronds display pinnae that are up to 8 inches long and 2 inches wide. These are lanceolate or often narrow long-triangular with an attenuate apex. The pinnule margins are entire to more often lobed with small distinct teeth usually arranged in pairs on each lobe, giving the pinnules a deeply serrate look. The indusia are quite thin, membranous and white, remaining so until they rapidly wither. The flat indusia have lacerate edges and overlap the sporangia just before maturing. As has been said, the spores are very dark.

Culture: This deciduous species needs a more protected spot than *D. filix-mas* as well as more moisture during hot weather, being less drought resistant than its hybrid offspring. It is a beautiful addition to the garden but should be left alone after planting, as it resents being pampered and definitely dislikes being dug up and moved after becoming established. Once established, it is a good dependable strong grower. As has been mentioned, it forms new crowns in cultivation more often than in the wild. In the author's garden, it grows best under medium light and seems quite at home surrounded by *D. sublacera*, lending an interesting contrast.

References:

The Cultivated Species of the Fern Genus Dryopteris in the United States (1999) American Fern Journal, Vol. 89 #1, Barbara Joe Hoshizaki and Kenneth A. Wilson, Vienna, VA.

A Monograph of Dryopteris in the Indian Subcontinent (1989) Bulletin of the British Museum, Christopher Fraser-Jenkins, London.

The Plantfinder's Guide to Garden Ferns (2000) Martin Rickard, Timber Press, Portland, OR.

A Guide to Hardy Ferns (1984) Richard Rush, British Pteridological Society, London.

- WANTED - Fern Related Clip Art

Please send material or
references to the editor at:

2003 128th Ave. S.E.
Bellevue, WA 98005
or Foliageg@juno.com

or to the designer:

Karie Hess
12160 Classic Place
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kariehess@comcast.net

A Flora of Friends

Alan Ogden

Birmingham, England

A garden is a collection of memories as well as an accumulation of plants, a flora of friends, an herbaceous border of happenings, a veritable vegetable mnemonic. Nearly every growing thing has associated memories of its origins, the person, place and time of its acquisition. Sometimes we get things by accident too - the not-so-welcome invader which comes up in the pot, the invasive plant which was next to the one we were given, reminders that our friends' gardens are sometimes as undisciplined as our own.

When I wander round our garden the ferns which have been accumulating for over thirty years awaken memories of all the friends and acquaintances who provided them because ferns, perhaps more than any other group of plants, are obtained from personal contacts rather than garden centres. Very few of us manage to grow ferns from spores but those who do often have a surplus for a successful spore sowing will produce ferns in plenty to pass around.

We moved into our house in 1970 and the ground attached was a wilderness of overgrown hedges, knee-deep lawns, nettles and bindweed but hidden underneath this exuberant vegetation was the skeleton of a once loved garden. A few plants had survived, rhododendrons, *Gladiolus byzantinus* and ferns in abundance. In the spring a few resolute daffodils appeared but the survival of the ferns was impressive. Only the male fern *Dryopteris filix-mas* and the Hart's tongue *Asplenium* (then *Phyllitis*) *scolopendrium* grew but it gave me ideas.

Shortly after our arrival here we went to a local private garden that was open for charity. It was the home of Ray and Rita Coughlin, gardeners of extraordinary skill and enthusiasm. It was an amazing experience but I was particularly impressed by the extensive collection of ferns that were growing out of doors - maybe they would grow in our garden too?

By chance the then secretary of the British Pteridological Society, "Matt" Busby, was also at the garden and he convinced me that the best way to obtain a collection of ferns was to become members which we did. He suggested a good book "Hardy Ferns" by Reginald Kaye, which was the only serious book for fern growers at the time. To my astonishment I discovered that Kaye's Nursery was at Silverdale in the Lake District where my parents had had a holiday caravan for years. This was an astonishing series of coincidences and I began to acquire my first ferns.

At that time I was impressed by the Victorian fern varieties and I bought a selection from Kaye's. Reg wrote the names on cardboard luggage labels that were attached to the pots with an elastic band. They had to wait a while before a place could be cleared for them and during this period the snails, which abound in our garden, ate the labels. We still have the ferns happily living with us and I still don't know exactly what they are, which is Wills and which is Dadds?

When my parents retired they went to live in Arnside, the next village to Silverdale and I used to call on Reg Kaye in his spectacularly ramshackle nursery - the weeds advancing on all sides and the wooden greenhouses were collapsed ruins. My mother remembered

it when it was smart and tidy and Reg used to exhibit at the shows. He used to potter about, puffing on his pipe and once he showed me round his private collection that was displayed among the natural outcrops of limestone around his house. He had some wonderful ferns including a stand of crested bracken *Pteridium aquilinum* 'Cristata'. Reg made his potting compost from the leaf mould in his garden and a lavish growth of wood anemone *Anemone nemorosa* would appear round each fern. I can recognise his ferns in our garden as they are still surrounded by anemones in the spring.

On one of my visits to Arnside my mother suggested I visit the garden of one of her friends, as she wanted to show me some interesting ferns. This was Mrs. Rose Butterfield who turned out to be the daughter of Robert Whiteside, one of the founding members of the B.P.S. who is immortalised in *Dryopteris dilatata* 'Crispa Whiteside'. Mrs. Butterfield only had a few of his ferns, the majority having been bought by Reg Kaye for very little money; she was still miffed about this. She made pressed dried flower arrangements as a hobby and always included a bit of one of her father's ferns.

Many years later when Mrs. Butterfield died she left me what ferns there were and her father's book "The Ferns of the English Lake Country" by W. J. Linton with Whiteside's name on the flyleaf and his original membership card of the Northern Pteridological Society which was formed in 1891. The ferns were excellent, *Asplenium scolopendrium* 'Crispum', *Dryopteris affinis* 'Cristata' and *Polystichum setiferum* 'Plumoso-divisilobum'. All have survived since Victorian times when Whiteside owned them. They are generous in forming offsets and I have given many away to friends.

Soon after we came to Birmingham I met Bill Laban, a tall and genial man who will not be known to fern growers but who will be familiar to many generations of Birmingham schoolchildren for he was the headmaster of an inner city school. He was always a keen gardener and his small garden in Quinton was a paradise in spring, a riot of colour from the dwarf azaleas and other small shrubs that were crammed into every available space. When he retired he took on other gardens. There was a school garden in central Birmingham and a much larger one with a stream in Chaddesley Corbett. The stream was made to course over many waterfalls to aerate it and then it was stocked with brown trout which he would catch for our tea when we visited.

Many of Bill's plants were vigorous and he gave away pieces generously. One clump of Pacific iris concealed the rhizomes of the Oak fern *Gymnocarpium dryopteris* which still rambles in our flower beds and when I made a bog garden from an old fishpond he helped me stock it with shuttlecock ferns *Matteuccia struthiopteris* and a very attractive form of American sensitive fern *Onoclea sensibilis* which has beautiful wine-red stems. He was not sure of its provenance and it is still causing debate even to this day. Bill also provided a crisped form of the Royal fern *Osmunda regalis* 'Undulata' and a fern that we used to call *Blechnum tabulare*, but which we now know is *Blechnum chilense*.

Ray and Rita Coughlin set up a poly-tunnel in their garden and went into the production of ferns in bulk for a nursery. Ray was an expert at growing from spores and he had many fine parent plants in his garden to provide them. Following the instructions in a Victorian fern book he produced an extremely delicate fine form of the Lady fern *Athyrium filix-femina* 'Kalothrix' which had been lost from cultivation for some time. He gave me one of these wonderful ferns but it was too delicate for my clumsy gardening and it died.

continued on page 28

A Flora of Friends *continued from page 27*

Ray used to examine every pan of sporelings for anything unusual and he could spot winners when they were very small. He gave me a variety of the Hart's tongue, one of his favourites, *Asplenium scolopendrium* 'Sagittato-cristatum' in which the frond was divided into three by growth of the two lobes at the base of the frond.

Another Ray, Ray Smith, who lives only a few miles away, found a strap-like form of the soft shield fern in an old garden and improved it by growing bulbils of increasing regularity until he had a very fine specimen which won prizes. This is still sold in the nurseries as *Polystichum setiferum* 'Ray Smith' but sadly Ray lost all the polystichums in his garden to disease. I still have one of the original irregular forms.

"Matt" Busby has given me many ferns over the years in particular a very nice crested male fern which came from the garden of another fern grower who had died, Henry Schollick, and an example of *P. setiferum* 'Moly's Green' which has lost its special green character over the years.

I must mention Jimmy Dyce who was such an important character in the fern world. I met Jimmy on many trips and admired his devotion to ferns. Jimmy never gave me a fern but I do have one of the artificially produced hybrids named *Polystichum x dycei* which was made by Anne Sleep at Leeds. It produces bulbils near the ends of the fronds so it is a simple matter to make more specimens for friends.

On a recent trip to Germany organised by Sue Olsen I was delighted to meet many more of Anne's hybrids that have entered cultivation in Germany via Professor Reichstein in Switzerland. We only had *P. x dycei* here but there are now a few more different ones coming along from bulbils. The German growers Herren Nittritz, Stobbe, Gassner and Peters were very generous with bulbils and Christian Kohout gave me a few other potted rarities that will soon be planted out to join the other friends in our garden.

Martin Rickard, who also went on the trip to Germany, lives only an hour away and when he was running his fern nursery I obtained many unusual species from him to try out in the garden. Many were ferns from the Himalaya collected by Christopher Fraser-Jenkins and as one would expect some have done well and some have struggled. It must be quite a shock for a fern from Nepal to meet our clammy Midland clay.

Martin's superb book on Garden Ferns has replaced Reg Kaye's book as my main reference.

Those are just a few of the folks who come into my thoughts as I walk round our garden, all lovely people. I thought you might like to meet some of them too.

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FURTHER REFLECTIONS ON APOGAMY AND ALTERNATION OF GENERATIONS – Part I.

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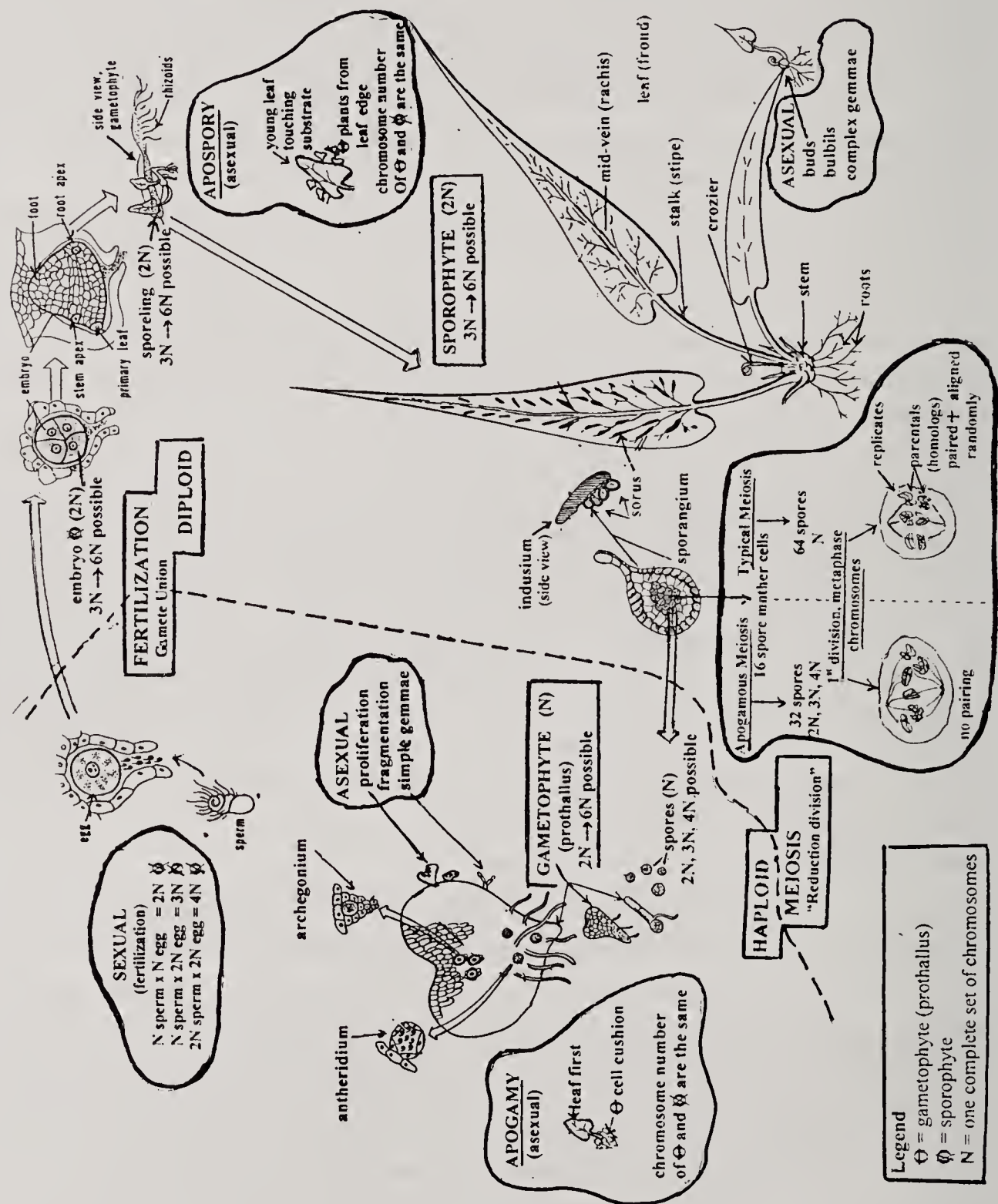
If “alternative lifestyles”⁽³⁾ appeal to you, you will love apogamy. Five to ten percent of the world’s 12,000 fern species appear to be apogamous (without gametes) – producing sporophytes directly from ordinary body cells of the gametophyte, rather than the “traditional marriage” of eggs and sperms to form embryos and sporelings (baby sporophytes). Apogamous species are common in many important fern genera, e.g. *Adiantum*, *Asplenium*, *Cheilanthes*, *Cyrtomium*, *Dryopteris*, *Notholaena*, *Pellaea*, *Polypodium*, *Polystichum*, *Pteris* and *Trichomanes*. However, Moran⁽³⁾ notes that apogamy is absent from such major genera as *Blechnum*, *Cyathea* and *Thelypteris*.

Before looking at the genetic, evolutionary, developmental and ecological fallout of the asexual, apogamous way of life, a review of the “typical” homosporous (spores of one size) fern life cycle is in order.⁽¹⁾⁽²⁾ There are actually two alternating, free-living, distinctive-looking fern plant bodies. The gametophyte (prothallus) is the sexual one – tiny, ephemeral, two-dimensional, tissue-thin, haploid (having one complete set [N] of chromosomes) and ribbon or heart-shaped with an apical growth notch (meristem). This little plant – the size of your smallest fingernail - bears sperms and eggs inside protective jackets (antheridia and archegonia respectively) on its rhizoid-studded underside. Following their release from an antheridium, flagellated sperms swim through a film of water and down open archegonial necks to fertilize eggs on the same or on a nearby prothallus - the latter being preferable for genetic variety. Thus begins the asexual sporophyte plant – eventually growing into the familiar fern of garden and woodland – large, long-lived, 3-dimensional, diploid [2N], producing leaves (fronds), stems, roots and complex tissues like xylem and phloem. The mature fronds bear jacketed sporangia, typically on the lower surface of the leaves and in clusters (sori) that form distinctive patterns. Young sori may be protected by an investment of hairs or by an overtopping tissue (the indusium) formed from an umbrella-like, leaf upgrowth or a rolled-under, foliar margin.

Inside each sporangium 16 diploid spore mother cells generate 64 haploid spores through a special sequence of two divisions known as meiosis. During the first division matching parental chromosomes (homologs) from sperm and egg replicate and pair together. The resulting tetrads (groups of four chromosomes, each comprising a pair of replicated homologs) line up independently of each other in the center of the cell (see diagram). The replicated homolog pairs are separated by contracting protein fibers and apportioned randomly to daughter nuclei. Maintaining the momentum, a second split quickly separates the replicates. Each resulting spore thus gets a full set of chromosomes [N] and a unique array - you might say a “shuffling”- of maternal and paternal alleles (mutational variants of a specific gene, like blood types A, B, O in humans). Survival and growth into prothalli is determined by environmental selection of the best “endowed” spores or the ones lucky enough to land on favorable substrates. At this point the chromosome numbers game and the dual generation life cycle come full circle in the “typical” fern.

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THE TYPICAL and EXPANDED FERN LIFE CYCLE



Alas, this textbook version is only part of the story. The green algae ancestors of land plants stranded at the damp edges of the drying, but still watery world of the Silurian era 350-380 million years ago, probably resembled the thalloid gametophytes of modern ferns. Haploid gametophytes and diploid sporophytes of these progenitors were visually indistinguishable (isomorphic) except for their reproductive cells. This is still true for extant green algae like sea lettuce (*Ulva*). It was the evolutionary unfolding and fine tuning of many latent and some new genetic sequences that produced the two very different looking (heteromorphic) plant bodies of our present-day fern flora – the “alternation of generations” taught in introductory courses and illustrated here. One has only to look at the diminutive, simple gametophytes vs. the huge, complex sporophytes of brown algae like giant kelps (*Macrocystis*, *Laminaria* et al.), with well-developed meristems and highly specialized cells, to realize that the genetic potential for divergence of body form was there from the “beginning”. It was the adaptational “tough love” of life on land that tweaked this malleable hereditary legacy by selectively switching genes off and on during growth, development and differentiation.

A free-living fern prothallus on land is an ecological oxymoron. Such a flimsy plant – essentially a sheet only one to several cells thick – is at constant risk of desiccation from sun and breeze. This is partially solved by habitat restriction (moist soils, clay banks) and by gamete protection (encircling antheridial and archegonial jacket cells). Wind is another terrestrial hazard, lifting a prothallus off its substrate despite downward growing cellular hairs (rhizoids) that provide a bit of anchorage. Finally, the need for a timely film of water in which sperms can swim often frustrates the ability of this Lilliputian plant to fulfill its sexual mission. On those rare occasions when the gametophyte is sexually successful its further growth is inhibited by hormones emanating from the rapidly developing sporeling, and its life is quickly ended by the sporophyte’s lethal shade. Talk about ungrateful offspring! Thus, the life cycle of land plants has been shaped by a selective imperative to minimize the size and longevity of the independent, vulnerable, sexual gametophyte (just enough to create a sporeling) or to move it inside the protective tissues of the mature sporophyte (as in the seed plants).

We can all agree that the fern sporophyte is much better adapted for life on land. It has absorbing/anchoring true roots, conducting/strengthening tissues (xylem and phloem), indefinite growth through meristems, broad, photosynthetic leaf surfaces, well-protected sporangia and at least two sets of chromosomes as a reservoir of genetic diversity and insurance against the mutational impact of atmospheric radiation. As described above, such a plant is latent within the genome of many algae, including those that gave rise to the first true land plants. What may have happened to bring forth such a sporophyte on land was the retention of the egg cell within an archegonial jacket firmly attached to, and nourished by, the gametophyte. This created a captive zygote that was subject to the physical constraints and chemical gradients of its parent thallus. A resulting

3-dimensional pattern of division produced an embryonic ball of cells with root and shoot meristems. The rest, as they say, is history.

I will cite four examples to show that the fern life cycle has amazing plasticity, interchangeability, even the capacity to bypass generations and survive without sexual re-

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Further Reflections on Apogamy and Alternation of Generations - Part I. *continued from page 31*

combination – admirably sculpted for endurance over long periods of time under an array of changing conditions. First, there are ancient gametophyte lineages of bristle (*Trichomanes*) and shoestring (*Vittaria*) ferns in Appalachia going back 35+ million years when a warm Tertiary climate prevailed in the northeast. Climatic cooling eventually eliminated the sporophytes of these tropical genera, but their gametophytes survived even the ice ages, huddled together on recessed, dimly illuminated, sandstone rock ledges without producing sporophytes. These “Appalachian gametophytes” are flashlight and hand lens finds. Colonies of *Trichomanes intricatum* resemble hairy tufts of felt, while those of *Vittaria appalachiana* look like tangled clumps of narrow ribbon. They reproduce and spread asexually by colony proliferation, fragmentation and dispersable gemmae, the latter resembling newly sprouted prothalli – filamentous and only a few cells long.

The second example is apospory (without spores) – another deviation from the traditional fern life cycle – this one with important implications for chromosome numbers. Aposporous fern sporophytes produce sexually competent gametophytes as direct outgrowths from the edges of young or depauperate fronds that make contact with the substrate, e.g. *Phyllitis (Asplenium) scolopendrium*, *Osmunda javanica*, *Polystichum angulare*, *Dryopteris affinis* and several species of *Trichomanes*. Tissue-cultured roots of *Pteridium aquilinum* generate aposporous gametophytes as the nutrient medium becomes exhausted⁽⁵⁾, so the trait is not limited to leaves. Apospory appears to be controlled by a recessive gene inherited in Mendelian fashion⁽⁶⁾ much like blue eyes in humans. Although it is not all that common under natural conditions, apospory is direct evidence of a developmental seesaw between gametophyte and sporophyte body forms. Let us look at the arithmetic of apospory. Because meiosis is bypassed, aposporously produced gametophytes have the same ploidy level as the parent leaf, typically 2N. When they reproduce sexually the resultant sporophytes will be 4N. In *Osmunda cinnamomea* similar-looking 1N, 2N and 4N gametophytes were obtained⁽⁴⁾ for research purposes through successive cycles of laboratory-induced apospory followed by typical sexual fusion within resulting prothalli.

Ferns as a group tend to have high chromosome numbers. Other than apospory, some of that is attributable to aberrant meiotic pathways that can generate “unreduced” [2N] spores followed by diploid gametophytes and tetraploid sporophytes (e.g. *Asplenium trichomanes quadrivalens*). More commonly, the high numbers arise through hybridization followed by spontaneous chromosome doubling (allopolyploidy), re-creating matching chromosomes for meiotic pairing and thereby restoring fertility. Such spontaneous polyploidy generally occurs in one of two ways:

- 1 A cell nucleus may undergo mitosis (equal division) but division of the rest of the cell does NOT follow. The two nuclei fuse, creating a polyploid cell. If that cell is a fertilized egg (zygote) the sporophyte that develops from it will also be polyploid.

- 1 The nucleus of a zygote may replicate its DNA and chromosomes, but actual nuclear division fails to occur. The undivided nucleus, with its doubled chromosome number, later undergoes normal mitosis and cell division, completing the pathway to polyploidy. This is called “endoreduplication.”

These interruptions, delays or deletions in the normal sequence of chromosome replication, nuclear division and cell division have been demonstrated in tissue cultures of *Osmunda* and *Pteridium*.⁽⁴⁾ They may be due to a paucity of energy or enzymes at a critical point. In any case, one in five North American fern and lycopod species arose through hybridization and follow-on polyploidy. Among these fertile, hybrid allopolyploids are *Dryopteris celsa*, *Cheilanthes intertexta* and *Cystopteris tennesseensis*. For these plants, double, triple and even higher ploidy levels appear manageable, even advantageous - widening their habitat tolerance and enabling them to colonize newly available areas. It may be part of the key to surviving geological and climatic shifts such as the ice ages. However, there are upper limits to the number of chromosomes that can be accommodated within a functioning cell nucleus. Hexaploidy [6N] appears, generally, to be that limit.

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Apogamous Ferns

Compiled by Tom Stuart

The marking **both** in the list means the species reproduces both by apogamy and sexual means. The two methods are sometimes reflected in morphologically separate subtaxa, sometimes by geographical origin, or perhaps neither. An absence of **both** should only be taken to mean no test has yet confirmed sexual propagation.

Adiantum

caudatum (*both*)
diaphanum (*both*)
hispidulum
tenue
philippense

Argyrochosma

formosa
limitanea

Asplenium

aethiopicum
apogamum
cheilosorum (*both*)
cataractarum
cordatum (*both*)
filipes (*both*)
flabellifolium
× heteroresiliens
hondoense (*both*)
mertensianum
monanthes
resiliens

Astrolepis

cochiensis (*both*)
crassifolia
integerrima
sinuata (*both*)
windhamii

Azolla

pinnata

Blechnum

fluviatile (*both*)
whelanii (*both*)

Bommeria

pedata

Cheilanthes

alabamensis
arizonica
bonariensis
brownii
cuneata
distans
eatonii
eckloniana
farinosa (*both*)

feei

hirta (*both*)

inequalis

involuta v. obscura

kaulfussii

lasiophylla

lindheimeri

nudiuscula

pumilio

sieberi (*both*)

tomentosa

villosa

viridis (*both*)

wootonii

yavapensis

Cheiloplecton

rigidum var. lanceolatum

Cyrtomium

caryotideum
falcatum (*both*)
fortunei
macrophyllum
hemionitis
yunnanense

Cystopteris

protrusa (*both*)

Davallia

repens

Deparia

japonica ?

Diplazium

dilatatum var. dilatatum (*both*)

dilatatum var. heterolepia

doederleinii

donianum

hachijoense

× kawabatae procumbens

kawakamii var. kawakamii

× nakamurae

simplicivenium

taiwanense

× takii

virescens var. virescens

virescens var. conterminum

virescens var. okinawaense

Dryopteris

acutodentata
affinis (*both*)
basisora
blanfordii
bissetiana
championii (*both*)
chinensis
cycadina
cystolepidota
decipiens
dickinsii
erythrosora
formosana
fuscipes
gymnosora
hadanoi
hakonecola
hondoensis
indusiata
integriloba
juxtaposita
khullarii
kuratae
lepidopoda (*both*)
namegatae
neorosthormii
odontoloma
pacifica
parrisiae
purpurella
pseudo-filix-mas
pycnopteroides
remota
ryo-itoana
sacrosancta
shibipedis
silvaticum
simasakii
sparsa (*both*)
stewartii
subbipinnata
sublacera
subtriangularis
tsugiwoi
tsutsuiana
varia
wallichiana (*both*)
yakusilvicola
yigongensis

Mildella

fallax
intramarginalis var. serratifolia

Notholaena

aliena

aschenborniana
californica (*both*)
galeottii
grayi
neglecta (*both*)

Ophioglossum

coriaceum (*both*)

Pellaea

andromedifolia (*both*)
atropurpurea
boivini
calomelanos
dura (*both*)
gastonyi
glabella (*both*)
intermedia (*both*)
lyngholmii
ovata (*both*)
pectiniformis

Phegopteris

connectilis (*both*)

Polypodium

scouleri (*both*)

Polystichum

kiusiuense
luctuosum (*both*)
mayebarae
monticola
neolobatum
rigens
tsus-simense
xiphophyllum

Pteris

biaurita
cadieri
cretica
excelsa
esquirolii
fauriei (*both*)
grevilleana
kuschiuensis
linearis
natiensis
setuloso-costulata
vitata (*both*)

Thelypteris

glanduligera
parasitica


A list of references for the species listed is available from Tom Stuart, tstuart@westnet.com or PO Box 517, Croton Falls, NY 10519.

Field Seminar – Biology of Ferns and Lycophytes

Dr. Robbin Moran, Curator of Ferns at the New York Botanical Garden, and author of *A Natural History of Ferns* will conduct a course covering the identification, phylogeny and ecology of ferns and lycophytes at the Eagle Hill Field Station of the Humboldt Field Research Institute in southeastern Maine. The class will run from August 21 to 27 and include lectures and field trips. University credits are available. For further information contact: Humboldt Field Research Institute, PO Box 9, 59 Eagle Hill Road, Steuben, Maine 04680-0009; 207 546-2821; Fax 207 546-3042; email office@eaglehill.us; www.eaglehill.us.

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